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Amphibious Assault Model (AAM) Application Support Package (ASP)

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The purpose of the model application support package (ASP) is to provide information about the Amphibious Assault Model (AAM) for use in future studies conducted for the Marine Corps. Accreditation of a model requires an assessment of the specific application to determine the suitability of the model to the intended purpose. While this ASP was developed in support of an accreditation process, it was decided that it would be useful to isolate the generic, vice application specific, information about the model in a separate document so that others considering the appropriateness of the model to another application might find this compiled information useful and time saving.

This document describes the AAM using the modeling taxonomy for warfare simulation, entitled SIMTAX, that was developed during a series of Military Operations Research Society (MORS) workshops in 1986 and 1987. SIMTAX was published by MORS and distributed by the Joint Staff (J8) as part of their 1989 catalog of models.

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PURPOSE

The purpose of this model accreditation review is to provide the decision makers with information enabling them to determine the level of confidence they can place in the portion of the AAAV Supplemental Analysis results that stem from models and simulations.

Prepared for: Ms Nora Slatkin, ASN (RD&A)
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SECTION 1. INTRODUCTION

1.1 Purpose

The purpose of the model application support package (ASP) is to provide information about the Amphibious Assault Model (AAM) for use in future studies conducted by Studies and Analysis Division of the Marine Corps Combat Development Command (MCCDC). Accreditation of a model requires an assessment of the specific application to determine the suitability of the model to the intended purpose. While this ASP was developed in support of an accreditation process, it was decided that it would be useful to isolate the generic, vice application specific, information about the model in a separate document so that others considering the appropriateness of the model to another application might find this compiled information useful and time saving.

1.2 Scope

This document describes the AAM using the modeling taxonomy for warfare simulation, entitled SIMTAX, that was developed during a series of Military Operations Research Society (MORS) workshops in 1986 and 1987. SIMTAX was published by MORS and distributed by the Joint Staff (J8) as a part of their 1989 catalog of models.

1.3 Organization

Section 2 describes the 19 October 1994 configuration baseline of AAM. This is accomplished with a simplified description of AAM and a brief summary of its development history. The model design used to simulate a vertical amphibious assault is described in section 3 with the use of some simplified logic flowcharts. This includes a description of the entities modeled and the interactions among them. This is typically referred to as the model's "engine." A discussion of the model assumptions is provided as well as the implications of the model design and its limitations.

The Marine Corps Advanced Amphibious Assault Vehicle Supplemental Analysis (AAAV/SA) Accreditation Team was primarily interested in evaluating surface assault system alternatives. AAM had to be modified to be suitable for use by the AAAV/SA analysts. Appendix A contains a description of the conceptual logic changes made to AAM in order to use the model to simulate a surface assault. Appendix B lists the AAM event names and descriptions. Appendix C contains a detailed list of the characteristics and state variables for each of the AAM entities. Appendix D lists and defines the acronyms used in this document.

SECTION 2. AAM CONFIGURATION BASELINE

The AAM baseline described in this ASP is based on the model source code, annotated with comments, which was made available on 19 October 1994 to the AAAV/SA Accreditation Team. Evaluating the AAM configuration baseline required a thorough review of the available source documents, and interviews with BDM employees, to describe how the model works, how the model was developed, how changes to the model are processed and controlled, and what user support functions are available, if any. This section of the ASP also summarizes the fundamental assumptions and limitations of AAM.

2.1. Model Description

The AAM is an event-driven, Monte Carlo model of amphibious operations which is designed to provide insights into alternative tactics, doctrine, and equipment that can be used to perform vertical and surface amphibious assaults, shore-to-shore vertical assaults, and general off-load operations, under a set of scenario-dependent constraints.

Originally built to support the U.S. Marine Corps in evaluating the vertical assault capabilities of different mixes of heavy- and medium-lift helicopters and tilt-rotor aircraft, the AAM is well suited to the analysis of even the most heavily constrained airlift problems. Unlike a capacity or tonnage-based methodology, AAM requires the analyst to construct a "load plan," describing each aircraft or ship load in detail, including the origination point (i.e., a specific ship) and the destination on the beach. Since in reality it is a rare occurrence for a transport craft to reach its capacity in tonnage or volume when carrying a military load (due to palletization and the outsized nature of large items), the load plan approach provides a more realistic, operational assessment of movement requirements and capabilities. AAM is capable of modeling multiple beaches and landing zones (LZs), with the ability of landing in the LZ, then moving to a beach, or subsequent objective.

A number of the aspects of an amphibious assault which may have random effects are included in the calculations. Break and repair rates, as well as attrition due to enemy fire, are modeled as stochastic processes. AAM typically is run for multiple (e.g., 100) repetitions to measure the expected value of these random effects, as well as the range of uncertainty of the problem being studied. It is a relatively small model written in approximately 3,200 lines of FORTRAN code.

2.2 Development History

AAM was developed by BDM to simulate the movement of troops and equipment ashore during an amphibious assault. The model as originally designed was intended to model the vertical assault portion of an amphibious assault. The model is a time scheduled, calendar-driven model. For the most part it is a determistic model; however it contains two stochastic elements. The first is the attrition of landing platforms and the second is the breakdown and repair of landing platforms. There is no explicit accounting for geometry (i.e. geometric coordinates) and terrain or sea features.

2.3 Configuration Management and V&V History

All model runs for a specific study are made with a single version of the model. The study version of the model and all input data files are archived and stored for approximately five years to ensure that additional investigation of study results, if necessary, will be consistent with the initial model runs. This means that the model is closely controlled by BDM's AAM software engineer and primary analyst, Mr. E. Bitinas. BDM conducted a systematic walk through of the model's design, operation, and test procedures with the AAAV/SA Accreditation Team.

BDM uses a standard configuration management procedure that has been applied to AAM. Changes to any model for a specific study are implemented and tested with oversight (two levels of oversight when practical). Source code changes to AAM are made only by Mr. E. Bitinas, after approval by Mr. M. Ellis (BDM Vice President for Systems Analysis). Changes to the model are documented by comments in the source code.

The history of the model's usage, any previous verification and validation (V&V) that has been conducted, its configuration management, and any endorsements are considered the credentials of the model. The AAM has never been formally verified or validated. Table 2-1 contains a list of studies which were supported by AAM.

2.4 Documentation

The only model documentation available from BDM was a comment-annotated source code. A copy of the code was provided to the Accreditation Team by BDM on 19 October 1994.

Table 2-1. Previous Studies Using AAM

STUDY	CUSTOMER/AGENCY	PURPOSE
MLR Cost and Operational Effectiveness Analysis (1994)	Assistant Secretary of the Navy for Acquisition	Four alternative aircraft were compared in a variety of tactical combat and logistics situations.
MLR Alternatives Comparison (1993)	Boeing Helicopter	Various MLR alternatives were compared in a variety of tactical situations.
V-22 EMD Scenario Development (1993)	Boeing Helicopter	Provided a landing schedule for a vertical assault to be used in the EMD trade studies. AAM results were used to calibrate Boeing and Bell models.
AAAV Alternative Block Upgrade Options Analysis (1992)	General Dynamics Land Systems	Assessed the value of upgrades to the AAV, including water speed, land speed armor and armament, in a Korean scenario.
V-22 Operational Effectiveness (1988/89)	Boeing Helicopter	Compared the V-22 with other helicopter alternatives in an Iranian scenario.
Mine Clearing Requirements Analysis (1987)	USMC MCCDC	Established the mine clearing levels for sea, shallow water, surf and beach mines to allow the USMC to conduct a survivable surface assault.
V-22 Effectiveness Comparison (1986/87)	Boeing Helicopter	Compared the V-22 with other alternatives in a Norwegian scenario.
Ship to Shore Mission Area Analysis (1987)	USMC MCCDC	Assessed the ability of the USMC to conduct amphibious operations, both vertical and surface assaults in a Pacific scenario.

SECTION 3. MODEL DESIGN

The model design is described in a table and a series of figures defining the conceptual logic flow of the model. First, the "entities" being modeled are described. These are the players in the simulation. Their capabilities to act are defined by general and unique characteristics. Next, a top-level view of the AAM conceptual logic for a vertical assault is presented. The next three figures describe the conceptual "engine" behind the model, i.e., these figures describe how the AAM entities' actions and interactions are simulated and how the records of the interaction outcomes are maintained. A summary description of the input and output data also is provided. This section of the AAM ASP concludes with a listing of the detailed assumptions used in the model, as well as a listing of the limitations of the model. As mentioned earlier, the AAAV/SA analysts were interested in using AAM for assessment of surface assault alternatives. Appendix A contains a description of the changes to the AAM conceptual logic flow that were required to simulate a surface assault.

3.1 Entities Modeled

Table 3-1 contains a list of the major entities used in the AAM for a vertical assault simulation. A more detailed description of the entity characteristics and state variables is contained in section 3.4, which covers the input data required for an AAM simulation run, and in appendix C. The purpose of this table is to facilitate the discussion of the model conceptual logic flowcharts in figures 3-1 through 3-4.

Table 3-1. AAM Vertical Assault Entities

ENTITY TITLE	REMARKS
Helicopter Types	Characteristics of each Status (e.g., availability, attrition, fuel remaining, etc.) Location
Ships	Number of landing spots on flight deck Helicopter fuel aboard Number and types of loads
Loads	Time scheduled to be at the beach Characteristics (e.g,. weight, CPI, personnel) Helicopter type needed to lift load Number of subloads
Subloads	Land vehicle characteristics (e.g., speed, weight, CPI, personnel)
Rendezvous Points (RPs)	Several RPs may be defined Organizes assault wave(s) for LZs
Landing Zones (LZs)	Destination of Loads (not subloads) Number and size of landing spots Each LZ can have no more than one beach
Beaches	Destination of subloads
Forward Arming and Refueling Point (FARP)	Refuel helicopters for return flight to ships LZ for helicopter fuel loads
Decision Point (DP)	Assign helicopters to ships/load
Key Distances	Ships to RPs and FARP RPs to LZs LZ to its beach LZs to DP and FARP FARP to DP DP to Ships

3.2 Vertical Assault Logic Flow

The following is a description of the top-level events that occur in the AAM to simulate the vertical assault. These events and their relationship to one another are graphically depicted in figure 3-1, which summarizes the AAM vertical assault flowchart. Figure 3-1 depicts the vertical assault in three segments: ship operations, the assault control points, and the ingress to, unloading at and egress from the landing zones and beaches. Attrition due to enemy fire is encountered in this portion of the model. Ship operations consist of the initial placement of helicopters among the ships, assessing the helicopter's operational status, repairing inoperable helicopters, and loading and launching helicopters. The ship operations are further described in figure 3-2. Loaded helicopters leave the ships and proceed to either a Rendezvous Point (RP) or, if the load is fuel, a Forward Arming and Refueling Point (FARP). At the RP the helicopters are assembled in waves before being sent forward to the assigned LZs. After unloading at the LZ, subloads proceed to their assigned beach. Unloaded helicopters return to the ships for the next set of loads by way of the Decision Point (DP). At the DP the helicopters are assigned to a specific ship, based upon available loads and deck space. These assault control points are described in more detail in figure 3-3. The focus during the flight to, the unloading at, and the flight from the LZs is attrition. Figure 3-4 describes these activities in more depth.

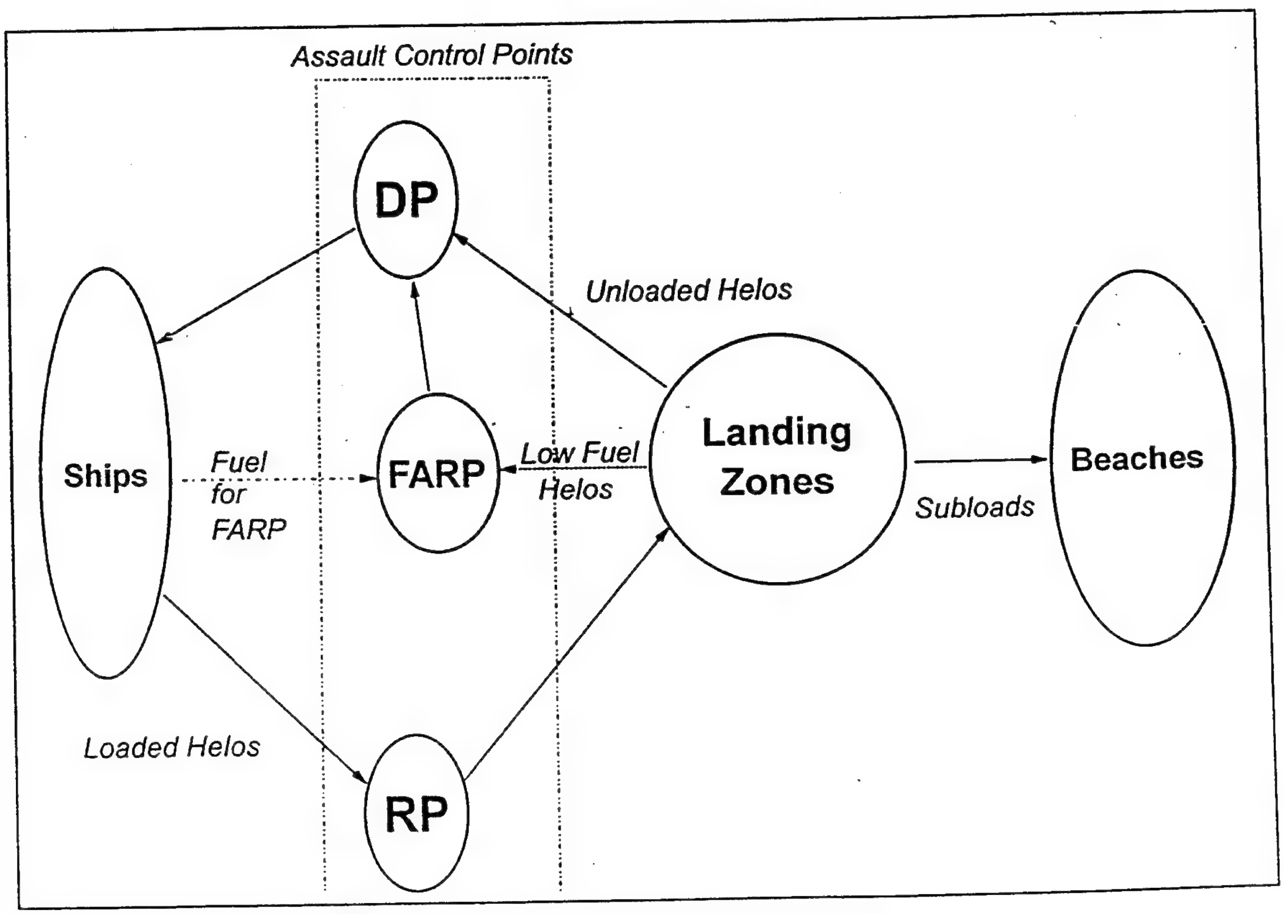

Figure 3-1. AAM Vertical Assault Flowchart

3.2.1 <u>Ship Operations</u>. As figure 3-2 illustrates, ship operations for a vertical assault starts with an event which initializes the status of the helicopters with respect to their location and operational status. Once assigned a ship the helicopters can be either inoperable or operable. If inoperable, they are sent below the flight deck of the ship for repairs. If operable, they are assigned to a flight deck spot or moved below decks to await a spot and a load. On the flight deck, the initial set of helicopters are assumed to be loaded and are ready to be launched. Other operable helicopters can be initialized as airborne and in an unloaded state, and located as returning to the ships at the DP. In fact, helicopter reinforcements can be entered into the simulation at a specified time during the assault. All of the airborne, unloaded helicopters enter the simulation at DP. After the initial set of loaded helicopters lift off the ships, they depart for either an RP or FARP, depending on their load. Ship operations consist of managing the flight deck spots and loading the next set of helicopters according to the load plan input data. Time lines for helicopter repair, movement above and below the flight deck, and helicopter takeoff and landing are all required input data. As helicopters arrive at the ship location from the DP, landing queues can be established. As helicopters depart the ship, flight deck spots become available and helicopters in the landing queue can land. Helicopters low on fuel are given a priority landing sequence. Once on the ship, the helicopter is checked to see if repair is required. If it is inoperable, or no load is available, it is moved below deck. Otherwise, it is refueled and loaded.

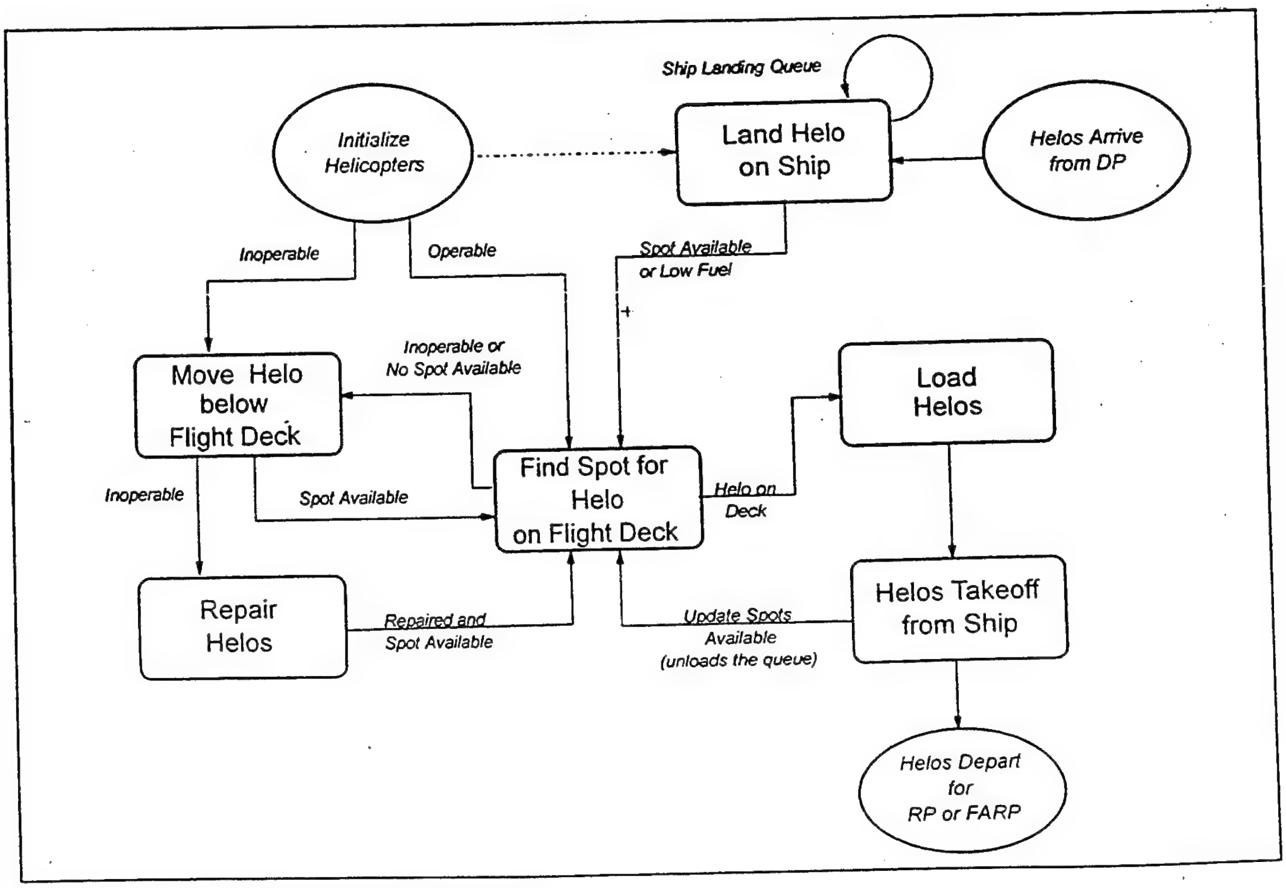

Figure 3-2. AAM Ship Operations for a Vertical Assault

3.2.2 Assault Control Points. RPs, FARPs, and DPs are defined in this document as assault control points because they are instrumental in executing the assault plan and its associated load plan. As figure 3-3 illustrates, the helicopters departing the ships fly to the assigned RP. There may be several RPs modeled to support a specific assault plan. At an RP, helicopters will form up into their waves, which results in a queue called the "inbound stack." There is logic in AAM to determine when a complete wave has formed up and is ready to depart for the LZ. There is also logic to push incomplete waves to the LZ before they run short of the fuel required to complete the mission. In this way, an incomplete wave will never wait so long at the RP that they cannot go to the LZ and then to the FARP. Helicopters carrying fuel loads proceed directly to the FARP. A landing queue can be encountered at the FARP since unloaded helicopters returning from their LZ can also arrive to be refueled. Helicopters low on fuel are given priority. Fueling queues may also be formed as the number of helicopters increases at the FARP. Helicopters returning to the ships from both LZs and the FARP go first to the DP. The DP, which acts as a Helicopter Direction Center (HDC), is where a helicopter is assigned its next load and ship. The logic for assigning the next load takes into consideration the type of helicopter involved and its limitations, and then, the logic searches for an eligible load with the lowest wave assignment. If multiple loads meet this requirement then the load is taken from the ship that is furthest behind in its unload plan.

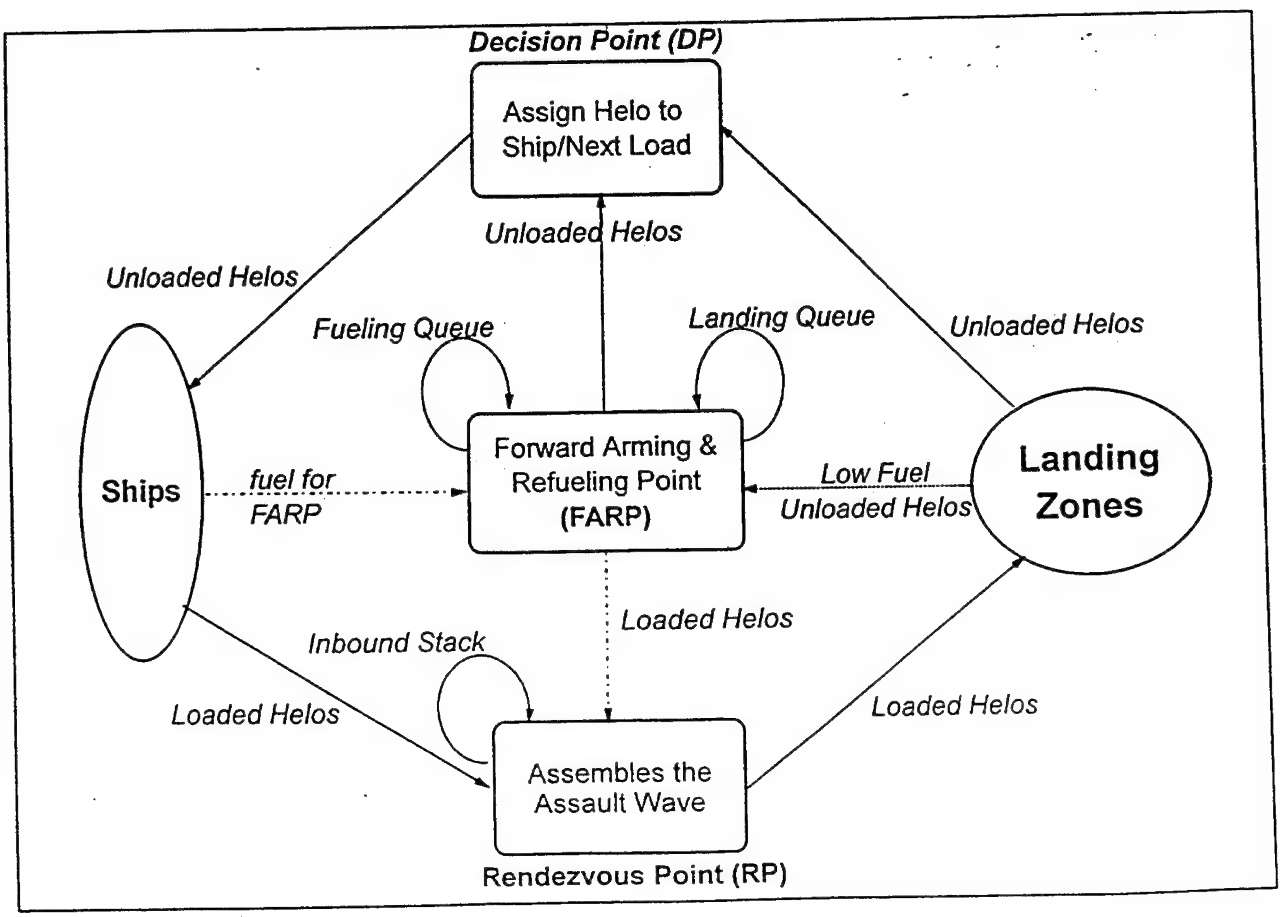

Figure 3-3. Vertical Assault Control Points

3.2.3 LZ and Beach Attrition Figure 3-4 describes these activities in depth. At the LZ, the helicopters are unloaded. The Combat Power Index (CPI), weight, and number of personnel in the load are all added to statistical counters. In the case of a subload with a speed greater than zero (indicating a vehicle) the counters are not updated until the subload arrives at the beach. Once a helicopter is done at the LZ, it takes off to proceed to the DP/HDC, or to the FARP if it needs to refuel.

Attrition occurs at four points in this section of AAM: the helicopter's ingress to the LZ; while unloading at the LZ; the helicopter's egress from the LZ to the DP or FARP; and the subload can be attrited on the way to the beach. The helicopter loss during ingress means the loads are lost as well. A helicopter loss at the LZ may lose all, some, or none of its loads, depending on the unloading status. A "killed" helicopter at the LZ has to be pushed from the landing site, which represents a delay for other inbound helicopters (LZ landing queue). Subloads attrited on the way to the beach means the CPI, load weight, and personnel are lost and not scored.

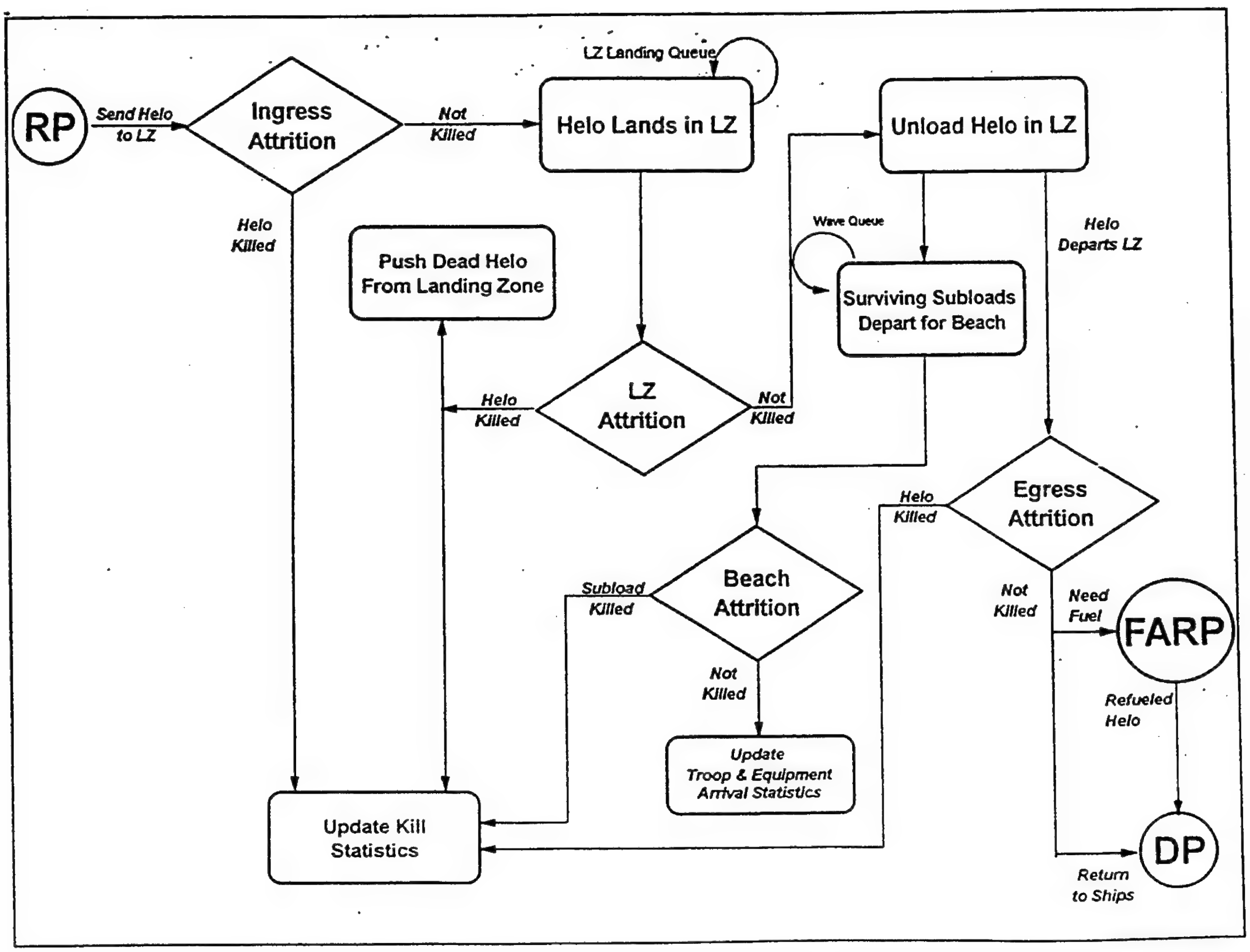

Figure 3-4. Vertical Assault Attrition

3.3 Stochastic Processes.

Random number draws are used in AAM to determine if the helicopters are operational when they arrive at a ship (this includes the initial assignments at the beginning of the simulation run) and to determine if the helicopters and the subloads (vehicles) survive their respective journeys to the LZ and beach. The expected operational availability rates and the attrition rates for each stage of the flight is required input data for each helicopter type used in the model. Similarly, attrition rates for each subload, or vehicle, type is required.

3.4 AAM Input Data

The model requires the following data in order to be run. Note that the entire landing plan needs to be formulated ahead of time so that the simulation can read it in as a first step. AAM requires five sets of input:

- Aircraft and/or surface craft characteristics, including speed, fuel consumption, break rates, repair times, operational ready rate, cargo capacity, and refueling rate

- Cargo characteristics including type, weight, cube, composition, transport speed, and loading and unloading time; and the type of vehicle that is used to carry it

- Scenario information including a geographic description of the airfields or amphibious shipping to be used, distance to air-to-air or forward area refueling points, prioritization of cargo loads, and distance to landing zones

- Loading Plan - A detailed load plan is required for each ship. The load plan can have a maximum of 132 loads per ship. There are a maximum of 52 possible different load types, because each load type is designated by either an upper-case or lower-case letter. The load plan for a ship lists the loads in sequence of desired offload from the ship. The loads are able to be broken down into waves and sent to specific landing zones by the use of character delimiters, i.e., backslashes (\) and ampersands (&). This provides the modeller with the ability to make sure that all the ships conduct the offload in a coordinated fashion, attempting to replicate the landing plan of an amphibious assault. Each helicopter will take only one load at a time. The development of the load plan calls for a large amount of work up front. Every item coming off the ships needs to be organized into a load type, then the modeller has to organize the loads so that they are realistically placed on the available shipping. The way the loads are spread throughout the shipping will impact how combat power is built up ashore, and should reflect realistic combat loading of amphibious ships.

- Attrition Rates - The attrition for the helicopters is done based on both the wave currently being sent to the LZ and the location of the helicopter. For each wave of the ship to objective movement, attrition data is required for the following: attrition

along the ingress route, attrition in the landing zone and attrition along the egress route. The first gate is between the RP and the LZ. A check is made upon arriving at the landing zone to see if the helicopter survived the ingress. The second gate is at the LZ as the helicopter unloads. A check is made to see if the helicopter survived during the time needed to unload each load in the LZ. If yes, then that load is added to the forces already ashore. If the helicopter did not survive, then each of the loads remaining onboard are lost with the helicopter. Each load surviving, that has subloads with a positive velocity, represents a load of at least one vehicle. For each vehicle, a random draw is made to see if it survives the trip to the beach. The third gate is between the LZ and the DP as the helicopter egresses from the LZ. A check is made to see if the helicopter survives the egress.

3.5 AAM Output Data

AAM calculates the time required to move the cargo; the utilization rate of the transport craft; fuel consumption (including air-to-air refueling); and the buildup of personnel, cargo, and/or combat power at the destination over time. AAM also provides as output, a planned arrival rate, vehicle by vehicle, for the entire operation. The time that each aircraft begins loading, finishes loading, arrives in the LZ, and completes off loading is recorded, along with the load type that it was carrying. This arrival schedule can be used for planning purposes or to create inputs to other models.

3.6 Detailed Assumptions

AAM makes the following assumptions:

- o Ships do not move or receive attrition.
- o Attrition is independent between aircraft and between waves.

3.7 Limitations

AAM has the following limitations:

- Modifications need to be made to handle LCACs versus helicopters, specifically well deck operations which are serial, vice flight deck operations which are parallel. (See appendix A.)

- The geometry of the model is based upon a network paradigm. There is no use made of grid coordinates or x-y coordinates. Instead the model knows the distances between all locations used in the model. Then using the distances and known speeds of entities acting in the model, the model computes the time needed to transit from point to point, and pushes the entities to their next location.

- The model makes use of attrition rates generated in other models or obtained from subject matter experts. For example, the Tactical Engagement Model (TACEM) has been used to generate attrition rates, by wave, for lift helicopters. Similarly, the Landing Assault Combat Engagement Model (LACEM) has been used to obtain attrition rates for surface assault landing craft. However, AAM assumes that no attrition occurs outside the domain of the supporting attrition models, e.g., 4,500 meters seaward of the high-water line on the beach in LACEM. The attrition models referred to in this example were developed by BDM.

APPENDIX A

SURFACE ASSAULT MODIFICATIONS
(19 October 1994 Version of AAM)

APPENDIX A
SURFACE ASSAULT MODIFICATIONS
(19 October 1994 Version of AAM)

A.1 Model Design

The surface assault modifications to the model design described in this appendix are application specific to the AAAV/SA. There remain inconsistences in the original AAM code that prevent its general use as a surface assault model. Its use as a surface assault model is incongruous with its original design. Although AAM functioned adequately as a surface assault model in the AAAV/SA, it should not have been deemed as a robust surface assault model without a major redesign effort. These modifications are described in a table and a series of figures defining the conceptual logic flow of the model. First, the "entities" being modeled are described. These are the players in the simulation. Their capabilities to act are defined by general and unique characteristics. Next, a top-level view of the AAM conceptual logic for a surface assault is presented. The next three figures describe the conceptual "engine" behind the model, i.e., these figures describe how the AAM entities' actions and interactions are simulated and how the records of the interaction outcomes are maintained.

A.2 Entities Modeled

Table A-1 contains a list of the major entities used in the AAM for a surface assault simulation. The purpose of this table is to facilitate the discussion of the model conceptual logic flow described in figures A-1 through A-4.

Table A-1. AAM Surface Assault Entities

ENTITY TITLE	REMARKS
Landing Craft Types	Characteristics of each Status (e.g., availability, attrition, etc.) Location
Ships	Number of well deck loading spaces Landing craft fuel aboard Number and types of loads
Loads	Time scheduled to be at the beach Characteristics (e.g., weight, CPI, personnel) Landing craft type to carry load Number of subloads
Subloads	Land vehicle characteristics (e.g., speed, weight, CPI, personnel)
Rendezvous Points (RPs)	Several RPs may be defined Assembles assault wave(s) for CLZs
LCAC Landing Zones (CLZs)	Destination of loads (not subloads) Number and size of landing spots Each CLZ can have only one beach
Beaches	Destination of subloads
Decision Point (DP)	Assign LCACs to ships/load
Distances	Ships to RPs RPs to CLZs CLZ to its beach CLZs to DP DP to Ships

A.3 Surface Assault - Conceptual Logic Flow

The following is a description of the key events that occur in the AAM to simulate the surface assault engagements, or interactions. Figure A-1 describes how the three types of landing craft that were used in the AAAV/SA were modeled: the Landing Craft Air Cushions (LCACs) with either swimming or nonswimming subloads, the AAAVs, and the AAVs. The legend in the figure describes the arrow symbols used to trace the route from the ships to the beach, for each type of landing craft, and its subload as appropriate. The landing craft depart the ships at the designated time, according to the load plan, and proceed to the RP to assemble in waves before departing to their designated CLZs. Note that there is no FARP in this version of the simulation. Three types of LCAC or landing craft landing zones (CLZs) are depicted in the figure, one for each of the three landing crafts (LCs) of interest. CLZ type 1 is where the LCACs deliver their swimming subloads, the AAVs. Essentially, CLZ type 1 becomes the Line of Departure (LOD) for the AAVs, approximately 4.5 Km from the high-water line on the beach. The AAAV transition from its high-speed configuration to its land operation configuration is modeled as CLZ type 2, with a "subload" that is the same AAAV traveling at a slower speed to its designated beach. The LCACs carrying non-swimmers to the beach, such as the Bradley Infantry Fighting Vehicle or M1A1 tanks, proceed directly to CLZ type 3. Only the LCACs continue in the simulation by returning to the ships for another set of loads. They proceed from their CLZ type 3 to the DP for an assignment to a ship for another load.

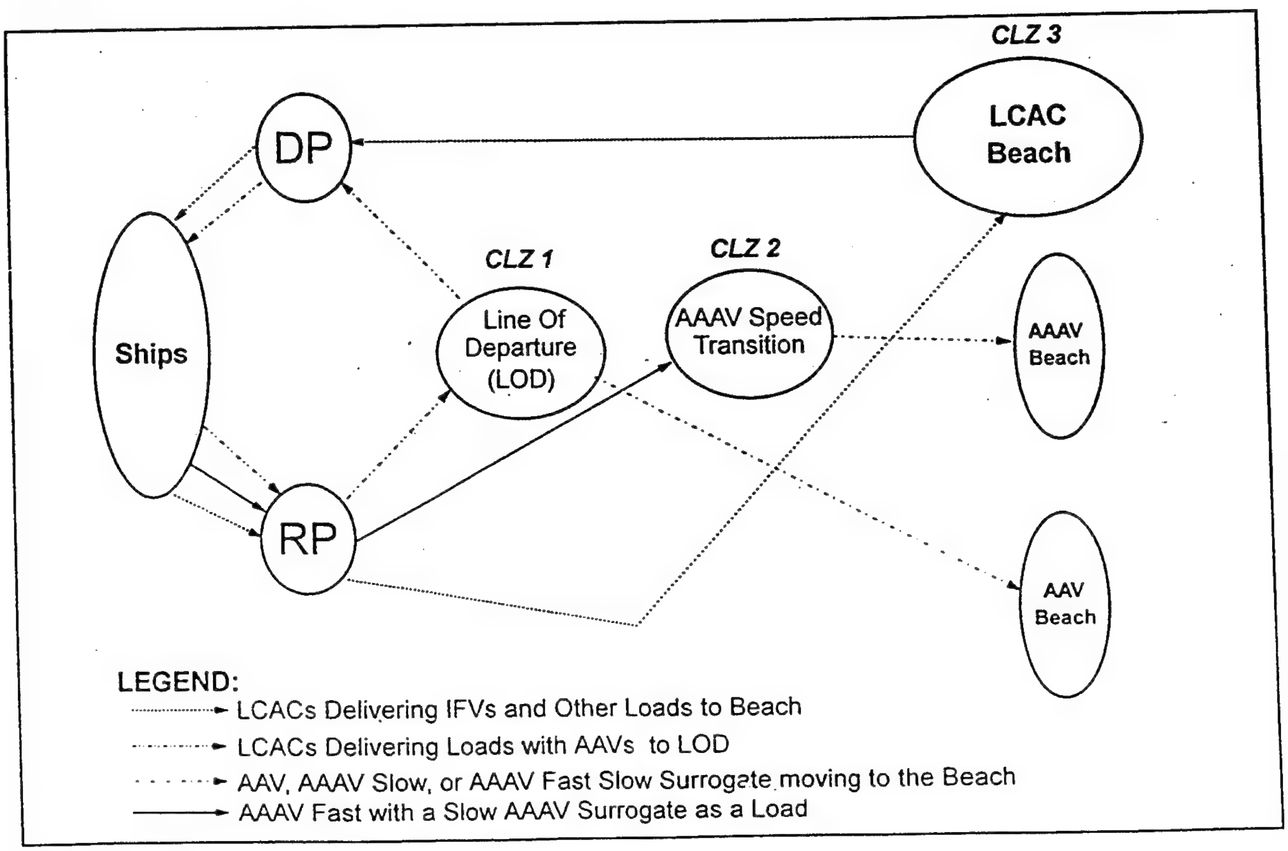

Figure A-1. AAM Surface Assault Flow Chart

A.4 Ship Operations

Figure A-2 depicts ships operations in support of a surface assault. The model initializes the status of the LC with respect to their location and operational status. The operational status is determined only at the outset of the simulation. If an LC is determined to be inoperable, based on the operational availability numbers provided as input data for that type LC, it is essentially removed from the simulation. The operational LC are assigned to spaces in the ship well dock for loading and remain operational throughout the remainder of the simulation. In the well deck, the initial set of LCs are assumed to be loaded and are ready to depart the ship. The initial set of loaded LCs depart the ships for their assigned RP. Ship operations consist of managing the well deck spaces and loading the next set of LCACs according to the load plan, since they are the only LCs which return to the ships from the CLZs. Time lines for LC movement to and from the well deck, and LC departure and landing at the ship, are all required input data. As LCACs arrive at the DP for a ship assignment, landing queues can be established to await well deck space. Because well deck spaces are serial in nature, i.e., first in is last out, the DP assigns the returning LCACs to ships in groups of one, two or three LCACs (according to the capacity of the well deck), to minimizes delays in accomplishing the loading plan. The next set of LCACs enters the ship only after the last LCAC in the previous group has departed.

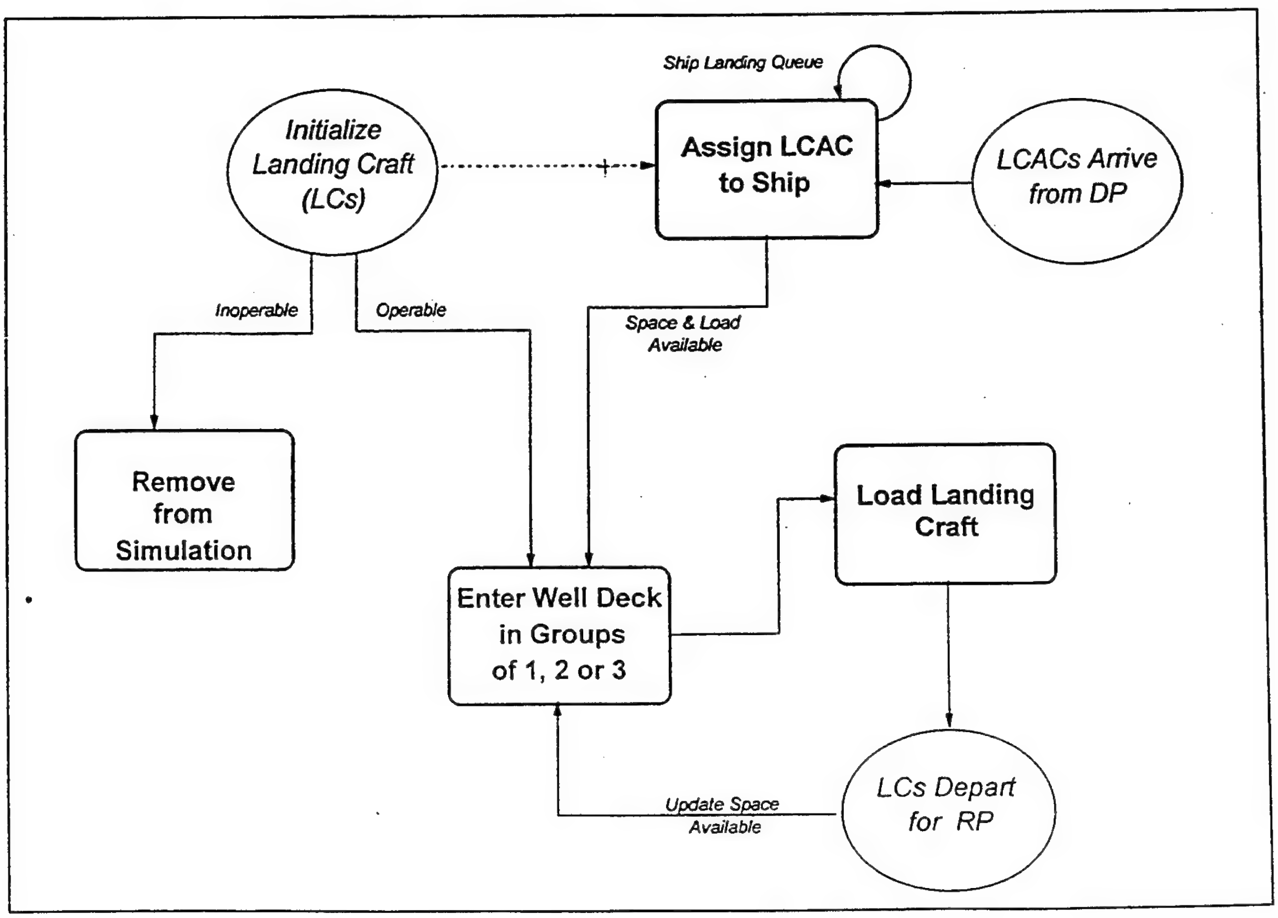

Figure A-2. Ship Operations for Surface Assault

A.5. Surface Assault Control

Only RPs and DPs are used as control points in the surface assault and they are instrumental in executing the assault plan and its associated load plan. The FARP function is not played. As figure A-3 illustrates, the LC departing the ships proceed to their assigned RP at their loaded speed. There may be several RPs modeled to support a specific assault plan. At an RP, the LCs will form up into waves, which results in a queue called the "inbound stack." There is logic in AAM to determine when a complete wave has formed up and is ready to depart for the CLZ. Unlike the vertical assault case, only complete waves go to the CLZs. Only LCACs return to the ships from the LOD CLZ and the LCAC CLZ (see figure A-2). At the DP, which acts as if it were a Primary Control Ship (PCS), the LCAC is assigned its next load and ship. The logic for assigning the next load takes into consideration the priority of the load, the number of well deck spaces available, and the load wave assignment. If multiple loads meet this requirement, then the load is taken from the ship that is furthest behind in its unload plan. The DP assigns the returning LCACs to ships in groups of one, two, or three LCACs, to minimize delays in accomplishing the loading plan.

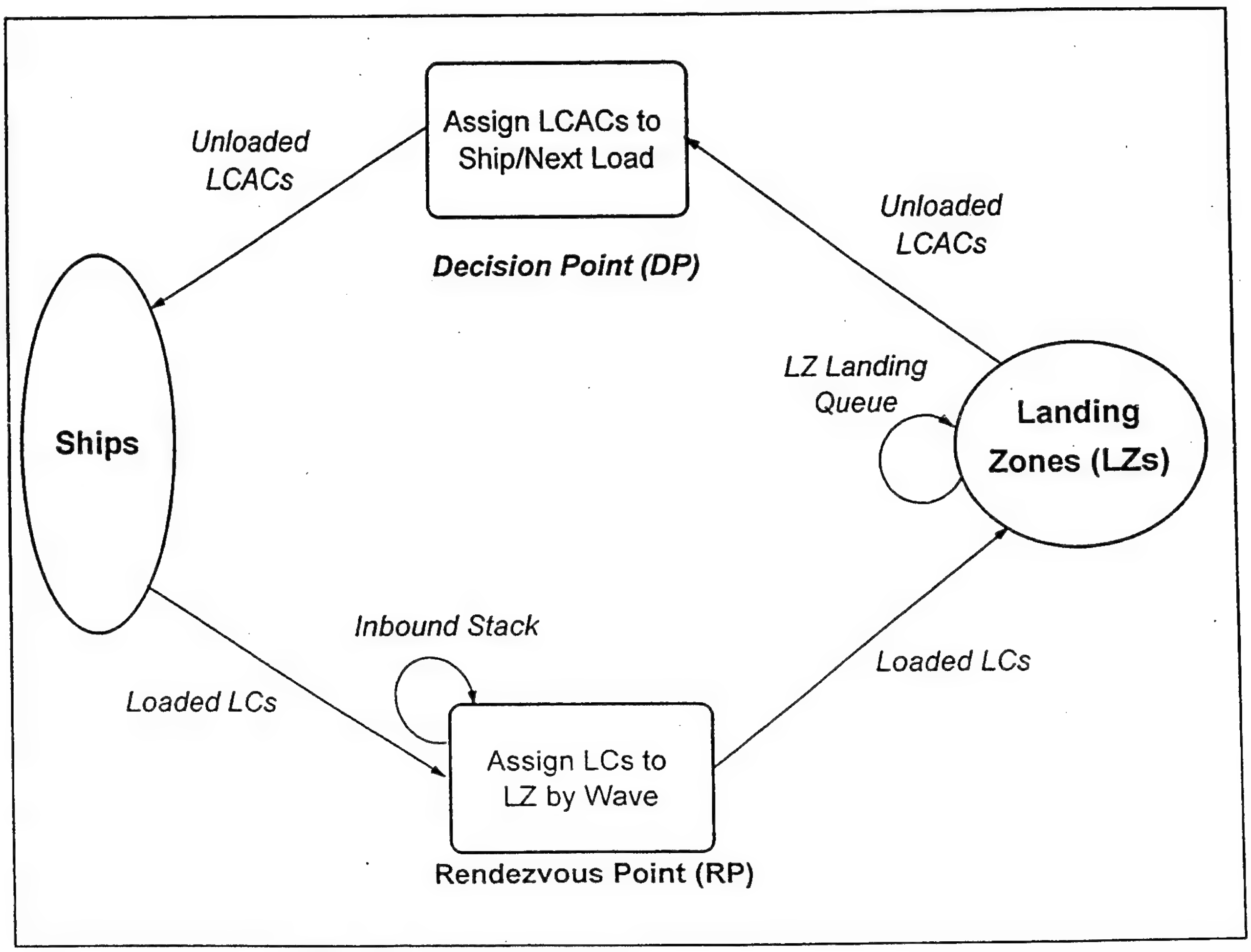

Figure A-3. Surface Assault Control Points

A.6 LCAC Landing Zone and Beach Attrition

LCAC Landing Zone (CLZ). At the landing zone, the loads from the LCs are unloaded. Then the CPI, load weight, and number of personnel in the load are added to the statistical counters. In the case of a subload with a speed greater than zero (indicating a vehicle), the counters are not updated until it reaches the beach. Once an LCAC is unloaded at the beach, it departs for the DP/PCS.

Attrition. Figure A-4 depicts the surface assault attrition. Attrition occurs at four points in this section of AAM: during the LC ingress to the LZ, while unloading at the LZ, during the LCAC egress from the LZ to the DP, and finally, during the subload (vehicle) movement to the beach. The loss of an LC during ingress means the loads are lost as well. An LC loss at an LZ may lose all, some, or none of its loads, depending on the unloading status. Subloads attrited on the way to the beach means that CPI, load weight, and personnel are lost and not scored.

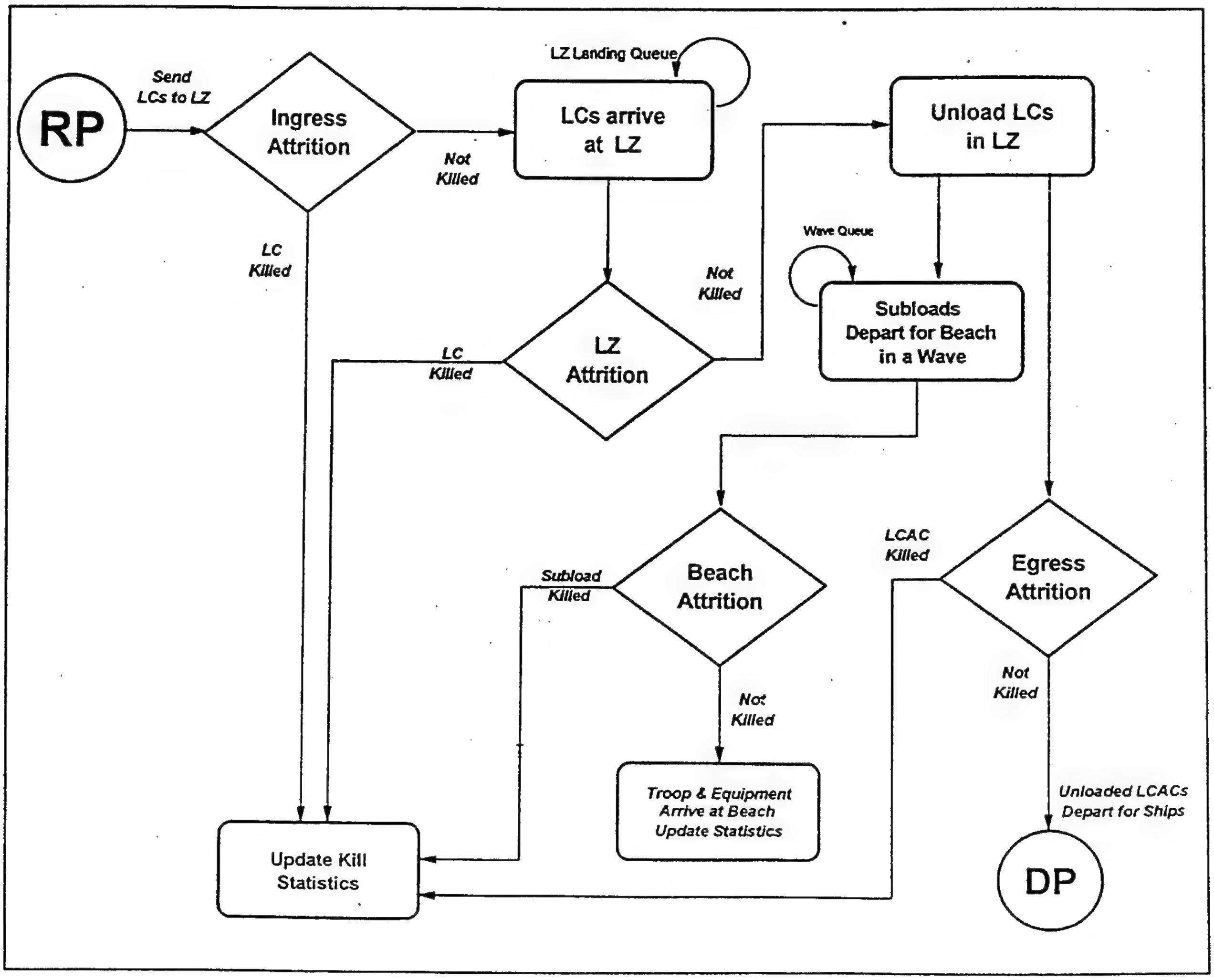

Figure A-4. Surface Assault Attrition

APPENDIX B

AAM EVENT NAMES AND DESCRIPTIONS

APPENDIX B

AAM EVENT NAMES AND DESCRIPTIONS

B2BINP - Definition of events and entities from input file

HININT - Initialization of carriers (either helicopters or landing craft or both)

HREPR - Repair inoperable carriers

FARP - Forward Arming and Refueling Point

HDCID - Decision Point (DP) - assigns carriers to ships/loads

HLOAD - Load carriers

HLNDS - Carrier "lands" on ship

HSSPT - Carrier is assigned spot on flight deck or space in well deck.

HTOFS - Carrier departs the ship for a rendezvous point (RP).

HBELO - If broken or if there is no load available, then moves carrier below deck. Returns carrier to deck when repaired and load is available.

HRNVO - Carrier arrives at RP.

HLNDL - Carrier "lands" at the LZ

HULOD - Carrier unloads at LZ

HSEND - RP assembles a wave of carriers and send to LZ.

HPUSH - If carrier is killed at LZ, time is taken to remove the carrier from the LZ

HITBH - Subload moves to the beach.

APPENDIX C

AAM MODEL
ENTITY CHARACTERISTICS AND STATE VARIABLES

APPENDIX C

AAM MODEL
ENTITY CHARACTERISTICS AND STATE VARIABLES

C.1 Helicopter Types.

The model has the capability to simulate a number of different type helicopters. The attributes describing the helicopter types are as follows:

- Number of helicopters available
- Spotting factor - the amount of space needed by the helicopter on the flight deck
- Speed when empty in knots
- Separation time in minutes when landing full
- Separation time in minutes when taking off full
- Mean time between field repairable failures in minutes
- Mean time to repair field repairable failures in minutes
- Maximum payload in pounds including fuel
- Maximum fuel capacity in pounds
- Duration of scheduled maintenance
- Maximum time of continuous operations in minutes
- Initial availability
- Mean time between catastrophic failures in minutes
- Mean time to repair catastrophic failures in minutes
- Time to configure aircraft
- Time to stow aircraft
- Total number of aircraft
- Separation time when landing empty in minutes
- Separation time when taking off empty in minutes.

C.2 Helicoper Fuel Usage Data Required.

Usage data required for helicopter fuel is described in the following items:

- Fuel used in pounds per nautical mile with an internal load
- Fuel used in pounds per nautical mile with an external load
- Fuel used in pounds per nautical mile with a combination load
- Fuel used in pounds per nautical mile empty
- Fuel used in pounds per minute while hovering empty
- Fuel used in pounds per minute while hovering full
- Minimum fuel reserves in pounds
- Fuel safety factor multiplier.

C.3 Loads.

The loads to be transported from the ships to the LZs/beaches are described by the following data:

- o Helicopter type that can carry the load
- o Time to put total load in carrier, in minutes
- o Time to unload, in minutes
- o Load delivery method, either internal or external or combination
- o Rate of travel when loaded in knots
- o Number of people in each load
- o Combat Potential Index (CPI) in load
- o Weight of the load, in pounds
- o Helicopter fuel in load (for FARP)
- o Desired pickup time (based on scheduled time to be on beach)
- o Initial delay, earliest pickup time
- o Alternative helicopter to lift load
- o Number of subloads in the load
- o Average speed of subload
- o Attrition of subload.

C.4 Ships.

Each ship is described by the following data:

- o Total helicopter spots on ship (flight deck and below deck)
- o Flight deck operating spots on ship
- o Initial LZ for load
- o Ship group
- o Time to add a new helicopter from below decks in minutes
- o Refueling rate in pounds per minute
- o Minimum delay time on ship to load
- o Time to move a new helicopter below decks, in minutes.

C.5 Landing Zones.

Each landing zone is described by the following data:

- o Number of LZ spots
- o Number of RPs for this LZ
- o Time to push a broken helicopter out of the way, in minutes
- o Landing number queue
- o Number of landing spots occupied
- o Landing time separation
- o Time of last assigned arrival.

C.6 FARP

The FARP site is described by the following data:

- o Number of helicopters in the FARP
- o Operating spots in the FARP
- o Fuel available in pounds
- o Refueling rate in pounds per minute
- o Time to push broken aircraft out of the FARP
- o Landing queue number
- o Fuel queue number.

APPENDIX D

ACRONYMS AND DEFINITIONS

APPENDIX D

ACRONYMS AND DEFINITIONS

Acronym	Definition
AAAV/SA	Advanced Amphibious Assault Vehicle Supplemental Analysis
AAM	Amphibious Assault Model
AAV	Amphibious Assault Vehicle
ASP	Application Support Package
BDM	BDM Federal, Inc.
CLZ	LCAC (or landing craft) Landing Zone
CPI	Combat Potential Index
DP	Decision Point
EMD	Engineering and Manufacturing Development
FARP	Forward Arming and Refueling Point
HDC	Helicopter Direction Center
IFC	Infantry Fighting Vehicle
J8	Joint Staff
Km	Kilometers
LACEM	Landing Assault Combat Engagement Model
LC	Landing Craft
LCAC	Landing Craft, Air Cushion
LOD	Line of Departure
LZ	Landing Zone
m	meters
MCCDC	Marine Corps Combat Development Command
MLR	Medium Lift Replacement
MORS	Military Operations Research Society
PCS	Primary Control Ship

Acronym	Definition
RP	Rendezvous Point
SIMTAX	Simulation Taxonomy
TACEM	Tactical Engagement Model
V&V	Verification and Validation